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SUPERSONIC

TRANSPORT

DEVELOPMENT

PROGRAM

PHASE III PROPOSAL

MOCK



BOEING SUPERSONIC TRANSPORT DIVISION

V2-B2707-2

SEPTEMBER 6, 1966

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Supersonic Transport Development Program
Phase III Proposal.
BOEING MODEL 2707.

Volume II-2.

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Office of Supersonic Transport Development Program

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1.0 SUMMARY

The use of mockups for design development provides for discovery and solution of configuration problems prior to release of production drawings. Mockups are therefore constructed early in the program to aid in design development and to verify design concepts. The mockups constructed during Phase II-C have been effective in developing the B-2707 configuration. These mockups are listed in the System Engineering Report V2-B2707-1.

The Phase III Mockup Plan is a planned extension of the Phase II-C Plan. Some new mockups will be constructed and some existing mockups will be updated to aid in developing an airplane that is producible, maintainable, serviceable, and appealing to the traveling public. The mockups planned for Phase III are illustrated in Fig. 1-1. The Phase III Plan is summarized in Table 1-A, and the schedule is shown in the Detail Work Plan (DWP) V5-B2707-4, Sec. 30-5.

2.0 MOCKUP USES

Airplane mockups are three-dimensional representations of the complete airplane, ground support equipment, or any portion thereof. They may be full or reduced scale as required to support the intended purpose. They are constructed of wood, metal, and plastic materials with dimensional accuracy sufficient to meet requirements.

Boeing mockups fall into one of three classes, the class and quality of each depending on its intended purpose. These classes are defined as follows:

2.1 CLASS I MOCKUPS

Class I mockups are expendable representations of specialized areas of structure and/or systems for engineering development of basic shape and space arrangements. Equipment representations are void of detail except as required to show operational or interface features. These mockups are used to coordinate space allocations between engineering design groups, to familiarize management with new concepts, and to present concepts for customer evaluation. They are constructed of inexpensive materials with dimensional accuracy maintained only as required by engineering.

2.2. CLASS II MOCKUPS

Class II mockups are used by engineering to develop and verify the design configuration prior to release of production drawings, to serve as an engineering tool to ensure proper coordination of hardware design between the various design groups, and to support design review. The coordination procedure accomplished through the use of the mockup vehicle serves to check the airplane design for accessibility, maintainability, serviceability, and consideration of reliability, value engineering, and human factor requirements.

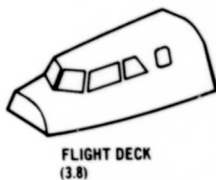
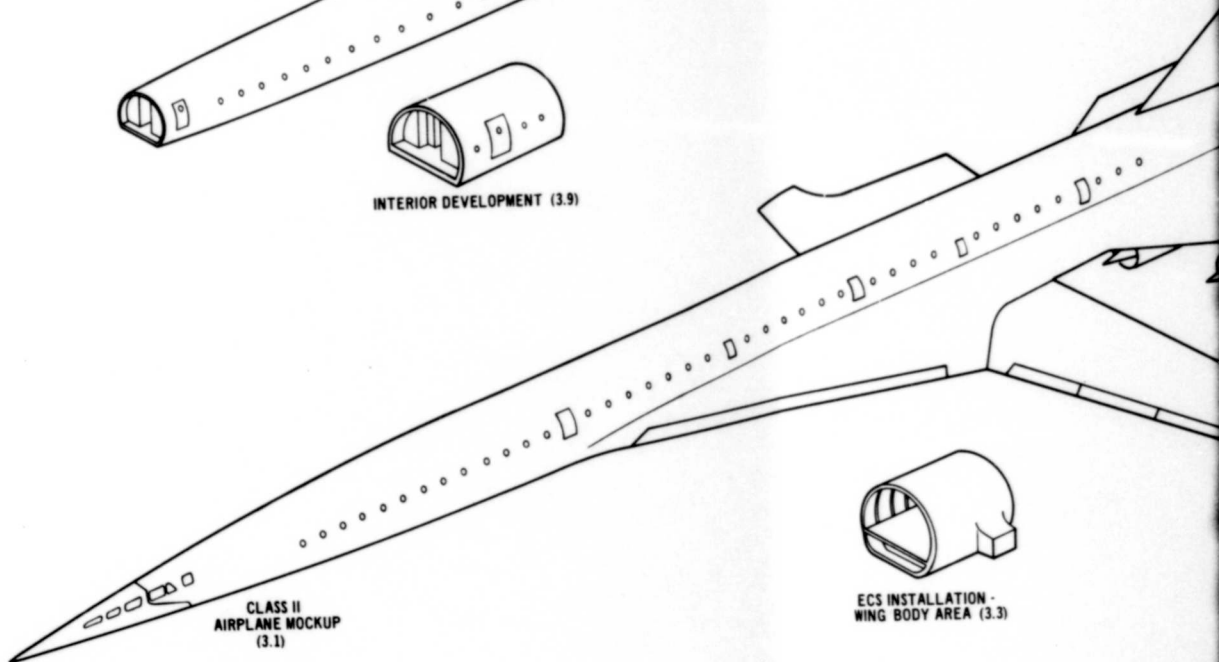
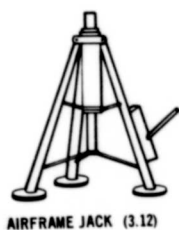
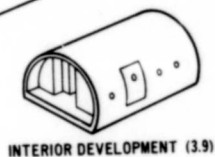
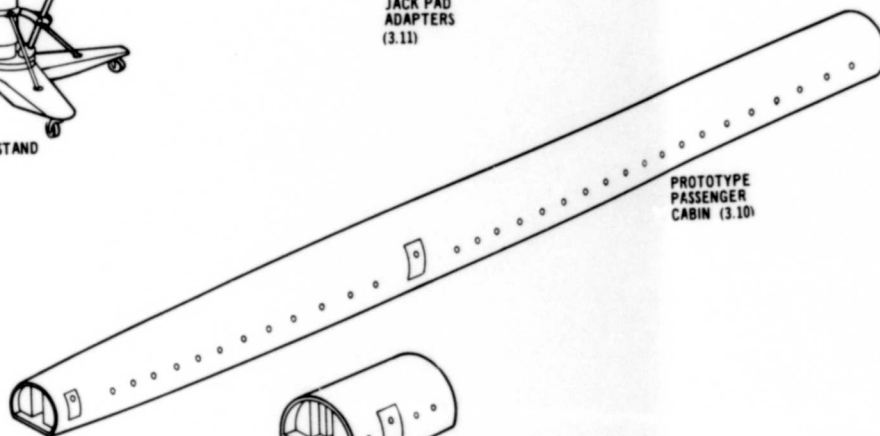
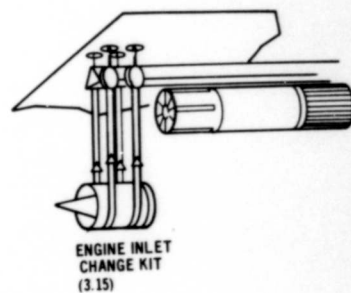
The engineering staff, service, training, and publication groups obtain benefits through three-dimensional visualization of integrated systems prior to completion of engineering design.

A Class II mockup serves to familiarize the manufacturing department with the airplane configuration so that preliminary planning can be performed for the tooling and production sequence and recommendations can be made to the engineering department for improved producibility.

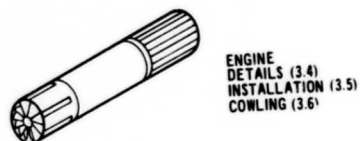
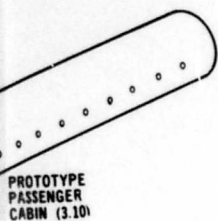
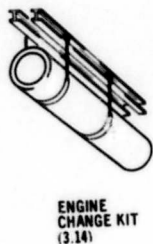
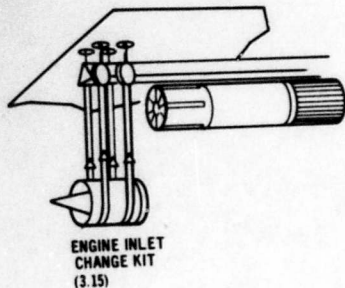
Customer appraisal of the airplane and systems configuration is obtained through the use of a Class II mockup.

Table 1-A. Mockup Summary - Phase III

DWP V5-B2707-4(REF)	MOCKUP	CLASS	PURPOSE
30-52a	Airplane	II	Verify design prior to release of production drawings
30-51a	Accessory Drive and Environmental Control Systems Installation	I	Develop space and arrangement requirements
30-51b	ECS Installation—Wing/Body Area	I	Develop space and arrangement requirements
30-51c	Engine Details	I	Develop size and shape
30-52b	Engine Installation	II	Develop space and arrangement requirements
30-51d	Engine Cowling	I	Develop cowl seals
30-52c	Engine Inlet	II	Verify concept and develop space requirements
30-52d	Flight Deck	II	Develop lighting requirements and verify equipment arrangement
30-51e	Interior Development Cabin Interior Lavatory Galley Service Unit	I I I II	Develop and demonstrate architectural concepts, arrangements, and operation
30-52e	Prototype Passenger Cabin	II	Develop and demonstrate interior configuration
30-51f	Jack Pad Adapters	I	Identify and establish airframe/GSE interfaces
30-51g	Airframe Jack	I	Determine spatial relationships with airframe
30-52f	Maintenance Platform	II	Verify design and demonstrate maintenance
30-52g	Engine Change Kit	II	Develop and demonstrate engine change concept
30-52h	Engine Inlet Change Kit	II	Develop and demonstrate inlet change concept
30-52i	Support Stand	II	Develop removal/replacement concepts for systems components
30-51h	Miscellaneous Ground Support Equipment	I&II	Identify and establish interfaces and allocate operating space



A



NOTE: FIGURE IN PARENTHESES INDICATES
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Figure 1-1. Phase III Mockups

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A Class II mockup is constructed of a good grade of wood, metal, and plastic, and the overall dimensions of parts are maintained as close to standard drawing tolerance as practical. Structure is usually simulation. Production materials and hardware may be used in critical areas. Sufficient detail is provided to demonstrate human factors consideration and the following interface relationships between:

- a. Systems
- b. Structure and systems
- c. Ground support equipment and systems
- d. Ground support equipment and structure

All systems components, including cables, ducts, representative tubing, and wire bundles, will be installed as required to ensure adequate space availability and interface compatibility. Interior lighting and all items which affect lighting, such as instrument panels, are installed in sufficient detail to ensure that the basic design is satisfactory.

While the Class II mockup is generally a complete representation of the airplane, specific requirements may dictate the need for individual Class II mockups of smaller sections to develop system/structure compatibility.

2.3 CLASS III MOCKUP

A Class III mockup is a full-scale representation of a portion of the airplane, constructed to develop manufacturing information for fabrication and installation of tubing, wire bundles, control cables, insulation blankets, and associated non-structural clips, angles, and brackets. It is essentially a manufacturing tool and is not intended to be used for formal customer inspection.

Materials used are representative of production requirements. Wood is used only in areas where clearances are not critical or in areas not involved in tubing, wiring, or insulation blanket development. All structure and systems are fabricated and installed to production tolerances. The final configuration of the nonstructural elements, such as tubing, wiring, control cables, and insulation blankets, is developed in the mockup and incorporated in the engineering drawings for release to the manufacturing department.

Manufacturing's method of developing the non-structural elements during Phase III is described in the Manufacturing Program V5-B2707-9, Sec. 5.0.

2.4 MOCKUP REVIEWS

Upon completion of a mockup, mockup reviews are conducted to formally investigate all aspects of the design. Refer to the Configuration Management Plan V5-B2707-1 for mockup review details.

3.0 MOCKUPS

Mockups were constructed during Phase II-C to aid in design development and to present design concepts to the FAA and airline personnel. These are listed in the System Engineering Report V2-B2707-1. A follow-on mockup program is planned for Phase III. These mockups are described as follows:

3.1 CLASS II AIRPLANE MOCKUP

A full-scale Class II mockup of the proposal airplane will be constructed to develop and verify the design prior to release of prototype airplane drawings. The mockup will serve as an engineering tool to coordinate hardware design between the various design groups, to check airplane design for producibility, maintainability, and serviceability, and to demonstrate design features to the customer.

The mockup will consist of a complete fuselage with pivoting forebody, complete left-hand wing with operating control surfaces and pivoting outboard portion of wing, stub of right-hand wing out to pivot, complete left-hand horizontal stabilizer with operating control surfaces, stub of right-hand horizontal stabilizer, vertical fin with operating control surfaces, one left-hand engine installation including the inlet and inlet control, one dummy left-hand pod, and retractable nose and left-hand main gear installations.

The following systems and their associated equipment will be installed: hydraulic, fuel, oxygen, water and waste, controls, fire detection/extinguishing, accessory drive, environmental control, electrical, communication, and navigation.

The passenger cabin interior will be complete to the extent necessary to verify interior installations and develop associated systems installations. The passenger evacuation slides will be installed to develop and demonstrate proposed emergency evacuation methods and conduct passenger evacuation tests.

The following product support requirements will be included to demonstrate servicing and maintenance requirements.

3.1.1 Decals will indicate all maintenance and inspection access panels and denote difference between structural and nonstructural panels.

3.1.2 Decals will indicate jacking, alignment, mooring, and hoisting points.

3.1.3 The following service points will be mocked up with appropriate access panels:

- a. Potable water
- b. Toilet drain, flush, and service
- c. Refueling panel and connectors
- d. Oxygen system
- e. Hydraulic system fill, drain, charge (accumulators), and external power points
- f. Ground electrical power receptacle
- g. Ground air-conditioning connection
- h. Ground pneumatic power connection
- i. External intercom jacks

3.1.4 Main entry, galley service, emergency, and cargo doors will be capable of simulating open and closed positions.

3.1.5 Both forward and aft cargo container loading systems will be capable of demonstrating the lifting of cargo containers from the baggage train into the cargo compartment.

3.1.6 The nose gear will show the tow bar attachment and torsion link disconnect, with decals showing maximum turning limits.

3.1.7 One main landing gear will be removable. Main gear components, such as drag links, actuators, torsion links, equalizer bar, and one wheel, will also be removable. Oleo oil and air servicing points will be shown. Gear and gear down-locks will be capable of being removed and installed.

3.1.8 The movable nose section will be removable.

3.1.9 One accessory drive system package will be removable to demonstrate removal and installation.

3.1.10 One engine will be mounted so that it can be removed and replaced. This will include removing the necessary fairing, cowl, quick-disconnects, etc.

3.1.11 One wing pivot will be realistic enough to demonstrate access for inspection, removals, and replacements.

3.1.12 One galley and lavatory will show disconnect points and be capable of being removed and reinstalled.

3.2 ACCESSORY DRIVE AND ENVIRONMENTAL CONTROL SYSTEMS INSTALLATION

A full-scale Class I mockup of the ADS and ECS installation in the horizontal stabilizer and the aftbody will be constructed to develop spatial relationships and establish interfaces and access requirements.

The mockup will consist of the aftbody from approximately Station 2980 to Station 3285, the left-hand horizontal stabilizer, simulated portion of the inboard and outboard engine installation interfaces, accessory drive gear boxes, engine connecting shafts, engine decouplers, accessories, simulated ECS and electrical equipment, air ducts, wire bundle envelopes, and simulated controls and tubing.

3.3 ENVIRONMENTAL CONTROL SYSTEM INSTALLATION (ECS)—WING/BODY AREA

A full-scale Class I mockup of the ECS installation in the cabin and wing box carry-through area will be constructed to develop routing of the intra-wall and cabin recirculating ducts, duct space limitations in the floor, and subsystems space and arrangement in the wing box bay.

The mockup will consist of approximately 12 feet of body section attached to a section of the inboard portion of the wing box front spar area. The intra-wall and distribution system ducts, wall lining, ceiling air outlets, and supply ducts in the wing box tunnel will be installed. Space provisions for the wire bundles will be shown.

3.4 ENGINE DETAILS

Full-scale Class I mockups of miscellaneous engine items, such as valves, hinges, electrical raceways, fireseals, electrical clamps, plumbing fittings, etc., will be constructed to develop size and shape.

3.5 ENGINE INSTALLATION

A full scale Class II mockup of a left-hand engine installation will be constructed to develop the installation physical requirements. Wire runs, plumbing lines, disconnect points, and cowl clearances will be established. This mockup will be installed on the Class II airplane mockup (Par. 3.1).

3.6 ENGINE COWLING

Full-scale Class I mockups of sections of the engine cowl will be constructed to develop seals and structure.

These mockups, constructed of metal, will simulate approximately 20-inch by 20-inch segments of cowl.

3.7 ENGINE INLET

A full-scale Class II mockup of the engine inlet will be constructed to aid in development of concepts and spatial relationships.

A complete inlet to match the airplane configuration and selected engine will be mocked up. It will include an operable centerbody, cowl, bypass doors, and actuators.

3.8 FLIGHT DECK

A full-scale Class II mockup of the flight deck will be constructed to develop, verify, and demonstrate lighting, glare prevention, instrument illumination, reflection, controls, and equipment arrangement and access. It will also be used to conduct human engineering studies.

The mockup will consist of the flight deck from approximately Station 500 to Station 755, windshields, windows, instrument panels with simulated instruments, controls, seats, lights, wiring, simulated equipment, etc.

In addition, the forebody and flight deck mockup constructed during Phase II-C will be retained during Phase III to conduct arrangement studies (Ref. V2-B2707-1). An interior view of this mockup is shown in Fig. 3-1.



Figure 3-1. Flight Deck Mockup

3.9 INTERIOR DEVELOPMENT

3.9.1 Cabin Interior—A full-scale Class I mockup of a passenger cabin interior will be constructed to aid in developing new architectural concepts.

The mockup will represent approximately 30 feet of passenger cabin interior and will include lining, lighting, window panels, stowage units, etc. The passenger lavatory, galley, and service unit mockups described in 3.9.2, 3.9.3, and 3.9.4, respectively, will be installed in this mockup.

3.9.2 Passenger Lavatory—A full-scale Class I mockup of the lavatory will be constructed to develop the spatial, functional, and servicing characteristics of the lavatory equipment proposed for the prototype airplane.

The mockup will consist of the lavatory shell, approximately 3 feet long by 4 feet wide by 7 feet high, and will include a dispenser cabinet, wash basin and base cabinet, toilet, mirror, lights, assist handles, etc.

3.9.3 Passenger Galley—A full-scale Class I mockup of a passenger galley will be constructed to develop operating characteristics of galley units incorporating a new concept in food service.

3.9.4 Passenger Service Unit—Full-scale Class II mockups of passenger service units will be constructed to develop, verify, and demonstrate arrangement and operation.

The mockups will be working prototype passenger service units complete with oxygen masks, plumbing, reading lights, air outlets, call buttons, signs, etc. Production or functional prototype hardware and equipment will be used.

3.10 PROTOTYPE PASSENGER CABIN

A full-scale Class II passenger cabin interior mockup will be constructed to develop and demonstrate the interior configuration for the prototype airplanes.

The mockup will represent the fuselage upper lobe from approximately Station 750 to Station 3050 and will include partitions, seats, lining, lighting, stowage units, operating galley, etc.

3.11 JACK PAD ADAPTERS

Full-scale Class I mockups of the jack pad

adapters will be constructed to identify and establish basic airframe/ground equipment interfaces on the Class II airplane mockup.

These mockups will consist of one forward airframe adapter, two rear airframe adapters, and two adapters for the outboard portion of the wing.

3.12 AIRFRAME JACK

Full-scale Class I mockups of airframe jacks will be constructed to aid in determining spatial relationships with airframe components, propulsion pods, and other GSE, and in establishing jacking points.

One forward airframe jack and one rear airframe jack will be mocked up.

3.13 MAINTENANCE PLATFORM

Two full-scale Class II maintenance platform mockups will be constructed to aid in design development of size, space, and positioning, to verify the design concept, and to demonstrate maintenance/GSE concepts.

The mockups will be approximately 30 feet long by 6 feet wide with an adjustable working height from 5 to 20 feet.

3.14 ENGINE CHANGE KIT

A full-scale Class II mockup of an engine change kit will be used to develop spatial and clearance relationships with engine inlet and maintenance platform, to aid in the establishment of interfaces, and to demonstrate engine change concept.

The mockup will consist of lift beams, mounting brackets, four commercially available hoists, and four interface fittings.

3.15 ENGINE INLET CHANGE KIT

A full-scale Class II mockup of an engine inlet change kit will be used to develop spatial and clearance relationships with inlet, engine, and maintenance platform, to establish interfaces, and to demonstrate inlet change concept.

3.16 SUPPORT STAND

A full-scale Class II mockup of a support stand will be used to aid in development of removal/replacement concepts for various empennage, wing pivot, wing control surface, and accessory drive system components. It will also serve to demonstrate component removal/replacement concepts.

3.17 MISCELLANEOUS GROUND SUPPORT EQUIPMENT

Full-scale Class I and Class II mockups of minor GSE will be constructed to identify and establish interfaces and allocate operating space. In general these mockups will consist of minor items of GSE used for removal and replacement of various airplane subsystem components.

3.18 USE OF PHASE II-C MOCKUPS

The mockups constructed during Phase II-C, except the anticollision beacon and the wing-body joint, will be used as required during Phase III for continued development studies and demonstration purposes. These mockups are listed in the System Engineering Report V2-B2707-1, with references to the documents which describe their contribution to the subsystem or configuration development.

4.0 MODELS

Since models are small-scale representations of the airplane or sections thereof, they can be located in the design group areas for the convenience of the design engineers. These models are frequently used to aid in design development

and to present design concepts to upper management and the customer. Models of this type will be constructed as required to support the SST Program.

5.0 RELATED PROGRAMS

5.1 SIMULATION PROGRAM

Refer to the Simulation Program V4-B2707-12 for relationship between mockups and simulators.

5.2 FACILITIES PROGRAM

Refer to the Facilities Program V5-B2707-7, Sec. 3.0, for the mockup facilities requirements.

5.3 TRAINING AND TRAINING EQUIPMENT PROGRAM

Refer to the Training and Training Equipment Program V4-B2707-7, Par. 4.2 for mockups that will also be used for personnel training aids.